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## Skin Conductance Module

The Skin Conductance Module continually measures the resistance between two surface electrodes. A change in this tonic skin conductance level (SCL) in response to a stimulus is known as the galvanic skin response (GSR).

All the physiological mechanisms contributory to this measurement are not entirely known, but skin conductance is largely proportional to the activity of the underlying sweat glands. Despite wide variations in techniques, SCL and GSR have been used in countless studies with good success. Also, this measurement is part of the array of measurements used by polygraph (the so-called lie detector) examiners.

The reciprocal of resistance is conductance. Skin conductance units are expressed as either micromhos or microsiemens. A 50,000 ohm resistor has a conductance of 20 micromhos or microsiemens.

The Skin Conductance Module applies constant 0.5 VDC to the subject through one electrode. There is a 100 ohm resistor in series with this electrode. The only return path for the subject voltage is through the other electrode into a 1000 ohm resistor. The subject completes the circuit.

It's the current flowing through the 1000 ohm resistor is measured and amplified. The amplified current signal is digitized with an analog-to-digital converter with 10-bit resolution. A running



**Skin Conductance Module shown with finger electrodes and USB cable. (The box actually has a rear battery door and does not have to be opened as shown to change the battery.)**

average is obtained by averaging each new raw measurement with the previous averaged measurement. New measurements are sent to the host at specified intervals. The input range is 0-40 micromhos.

The Skin Conductance Module is essentially a serial device. It comes populated for either RS-232 or USB operation. The USB connection appears to the operating system as another COM port. This device transmits digitized ADC data as a 10-bit number right-justified in two bytes—high byte, low byte. The default serial parameters are: 19.2 kbps, 8 data bits, one start bit, one stop bit, and no parity.

The box transmits one two-byte reading about 360 times a second by default. This rate can be varied by command. The device is always converting SCL data at 720 Hz. Subsequent readings are averaged with the previous reading (which was similarly averaged).

One of the outstanding features of the Skin Conductance Module is its ability to calibrate its own input. Internally, there are seven 0.1% precision calibration resistors connected to seven poles of an 8-pole analog switch. The eighth pole is the subject (switch 1). Any or all of the switches can be enabled with a corresponding bit in a control byte being set equal to 1.

<b>Calibration Switches</b>	Any or all of the switches can be enabled simultaneously. This allows multiple calibration resistors to be placed in parallel to obtain more calibration points.
S1 = subject	For example, either S2 or S3 may be engaged separately to calibrate at 10 micromhos. If both S2 and S3 are engaged, a 20 micromhos calibration point is obtained. Up to 20 unique calibration points can be generated in this fashion.
S2 = 51.0k	
S3 = 100.0k	
S4 = 100.0k	Be sure to open the subject switch during calibration and close it afterward.
S5 = 200.0k	
S6 = 1M	There is also a 12-bit digital-to-analog converter (DAC) that can be used to suppress (reduce) SCL. This could be used in situations where the subject has a large baseline offset SCL.
S7 = 1M	
S8 = 1M	

The serial interface is self-powered. That is, the USB or RS-232 connection provides all the requisite power to run the computer interface. The subject readout is powered by a 9V alkaline battery. The two halves of the circuit are optically isolated. The subject connection is floating relative to the computer and power line ground. The circuit provides in excess of 1000 V of isolation.

The 9V alkaline battery should last 20 to 36 hours of continuous operation. There is no power switch. Power to the subject readout circuit is actuated by asserting the DTR line of the serial interface. Deassert DTR to turn off the power.

## Commands

All commands are sent at 19.2 kbps. All command sequences start with a FF (hexadecimal) sync byte. There are 7 commands. Hex bytes values are shown:

- FF 9D — returns device id: "CRLFMindTel SCL 1.0CRLF" CR and LF denote carriage return and line feed, respectively.
- FF 99 cx — sets number of samples between sent samples.  $720.4611/(cx+1)$  samples/sec are sent. cx=1 by default.
- FF D0 dh dl — sets 12-bit suppression DAC. dh is high byte; dl is low byte. dldh range is 0-4095.
- FF CC sx — sets analog switches. sx enables any switch with a corresponding bit=1. sx=1 by default. Use this for cal. sx=0 opens all switches.
- FF C0 — sets analog switch 1 on.
- FF DF — inhibits transmission of data.
- FF CD — resumes sending data.